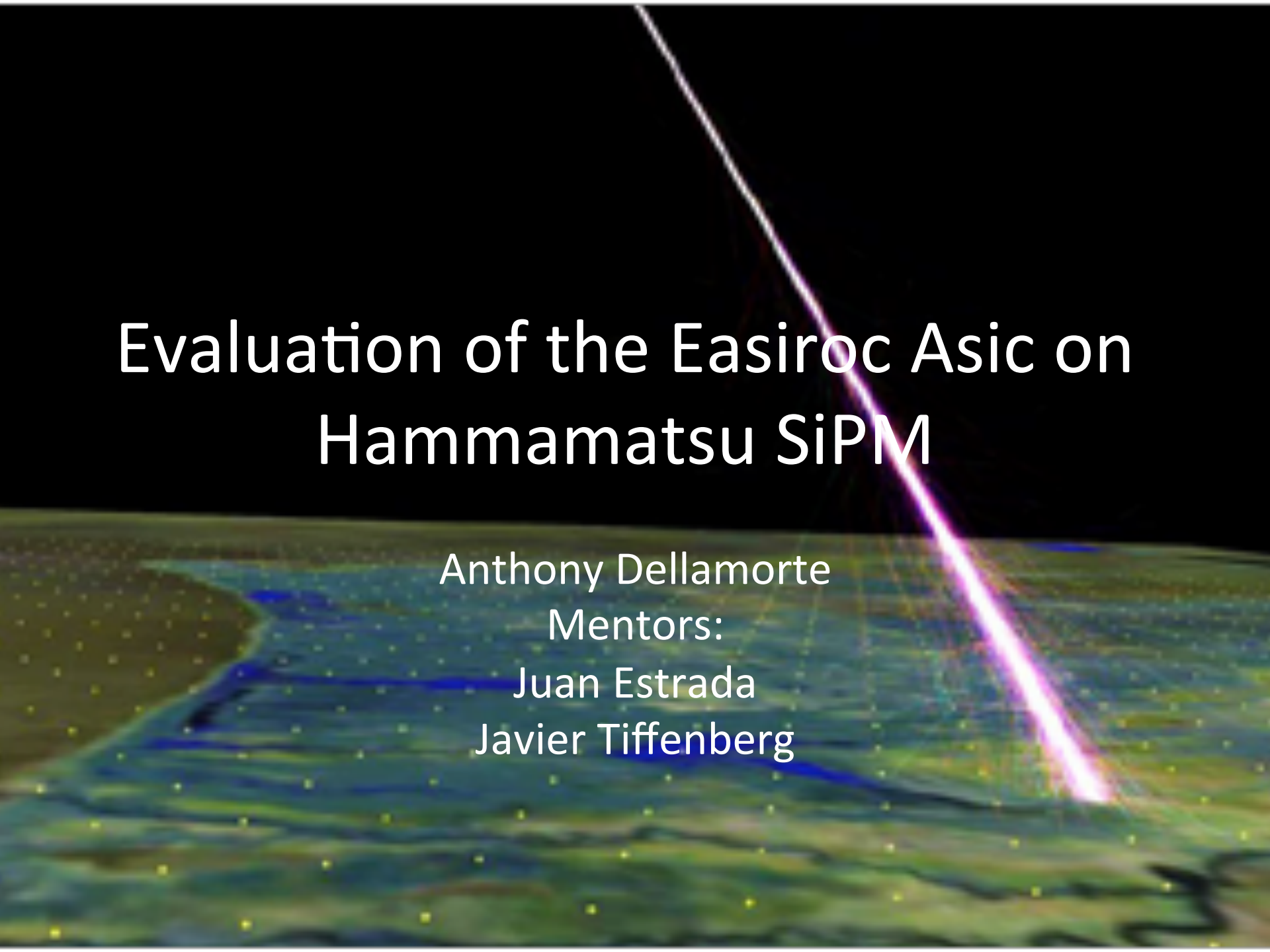

Evaluation of the Easiroc Asic on Hammamatsu SiPM

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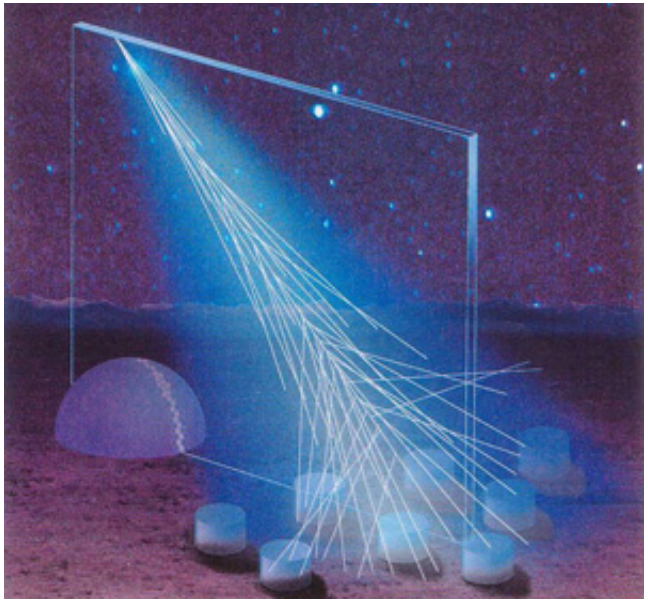
UHECRs

- UHECRs are cosmic rays that enter the Earth's Atmosphere with an energy level higher than 10^{18} eV.
- Very Infrequent
  - Above the energy of 10^{18} eV, only one particle each week falls on an area of one square kilometer.
  - Above the energy of 10^{20} eV, only one particle falls on a square kilometer in a century!

Pierre Auger Observatory

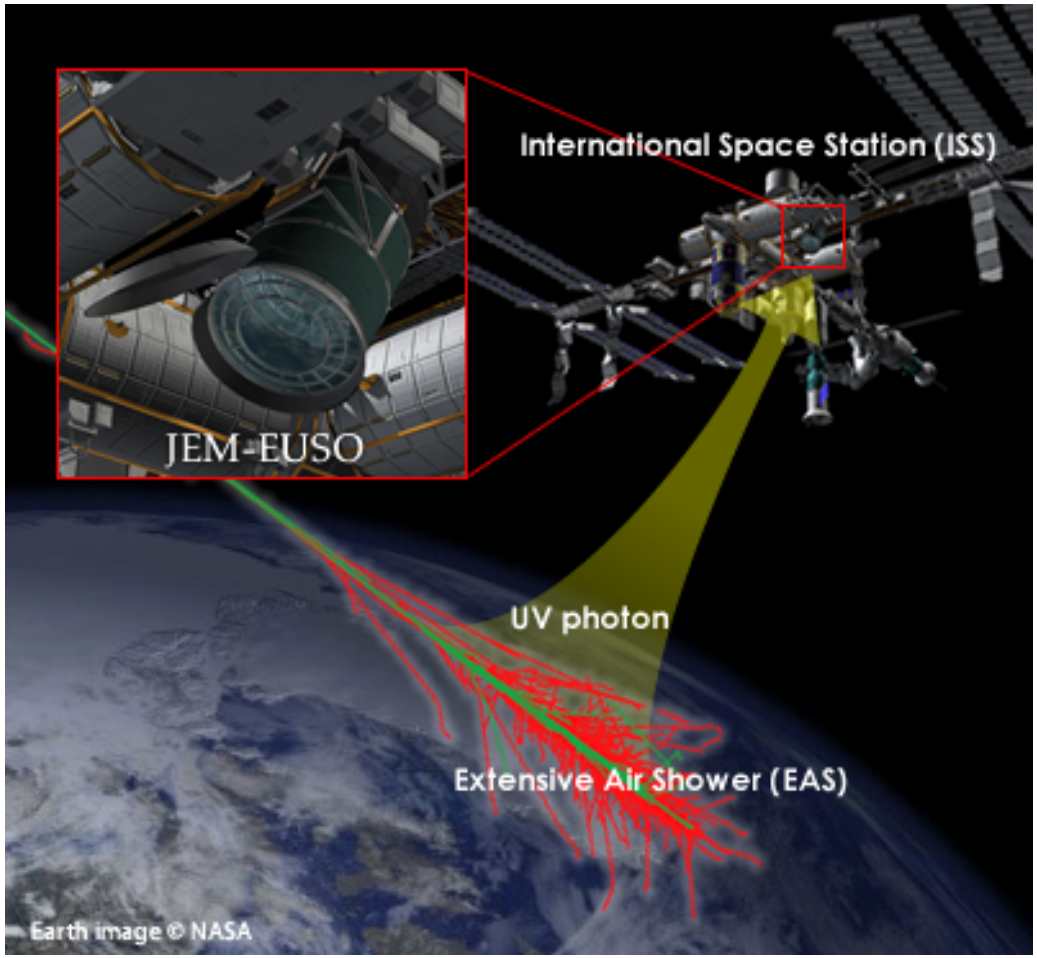


- Auger Observatory
  - Located in Argentina
  - 1600 sensors
  - spread in a grid 1.5km apart
  - Uses a huge area to increase the frequency UHECR hits
  - Limited by the amount of space they can build detectors and the resources to build them

JEM-EUSO

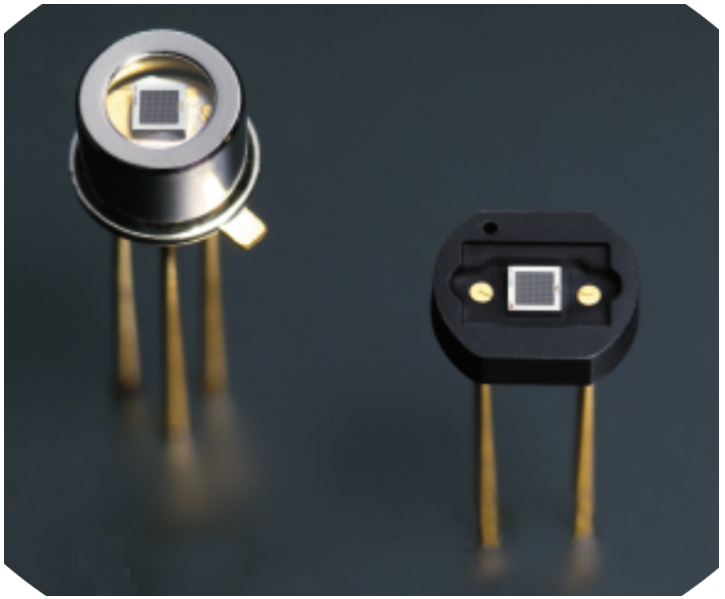
- JEM-Euso is proposing a telescope that will be mounted on the ISS.
- This telescope will look down on the Earth's atmosphere for UHECRs
- By looking from the ISS we can achieve a much wider field of view and observe UHECRs every 90 minutes.

JEM-EUSO


International Space Station (ISS)
JEM-EUSO
UV photon
Extensive Air Shower (EAS)
Earth image © NASA

Silicon Photomultipliers

- To look for the UHECR in the atmosphere it has been proposed to use SiPMs.
- These devices are well suited to the ISS because of their low power consumption and versatility.



Current Research

- To use the SiPMs on the ISS we must meet specific power requirements.
- We must also have an ASIC that will be able to read out multiple channels of SiPMs with a discriminator.
- Over the next year we must decide which ASIC will meet all the requirements of the experiment and the limitations of the ISS.

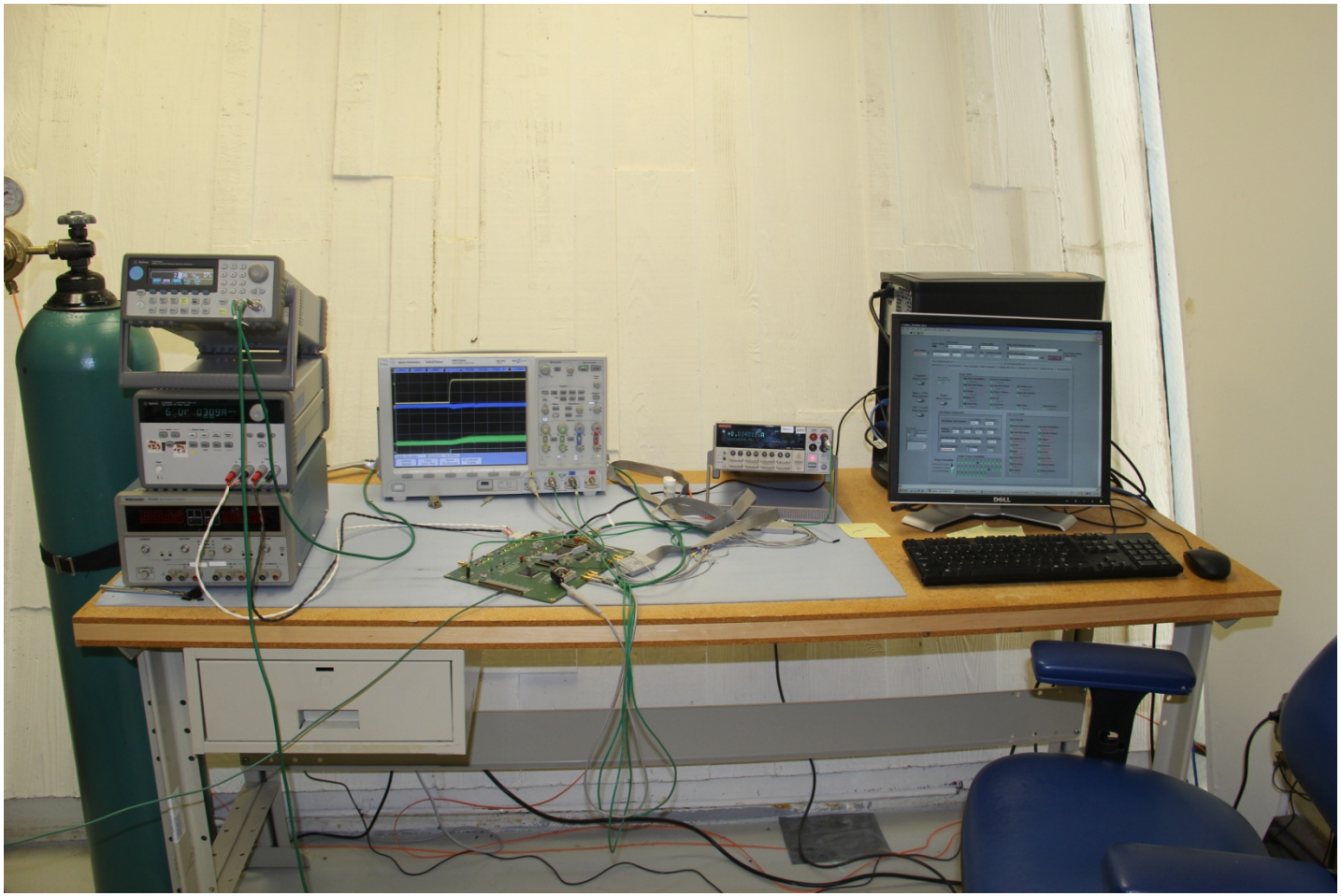
EASIROC

- The Omega EASIROC is a front end ASIC designed to read 32 channels of SiPMs.
- It currently requires 4.8mW per channel which does not meet the ISS requirements.
- It does however have the capability of disabling any features that are not necessary to save on power consumption.

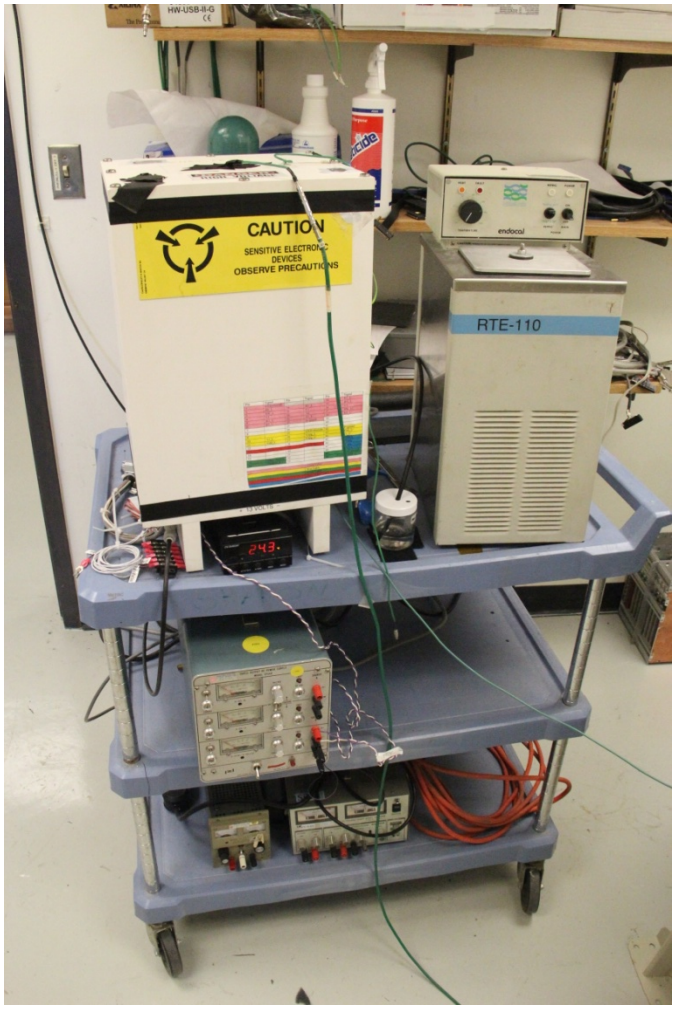
Summer Experience

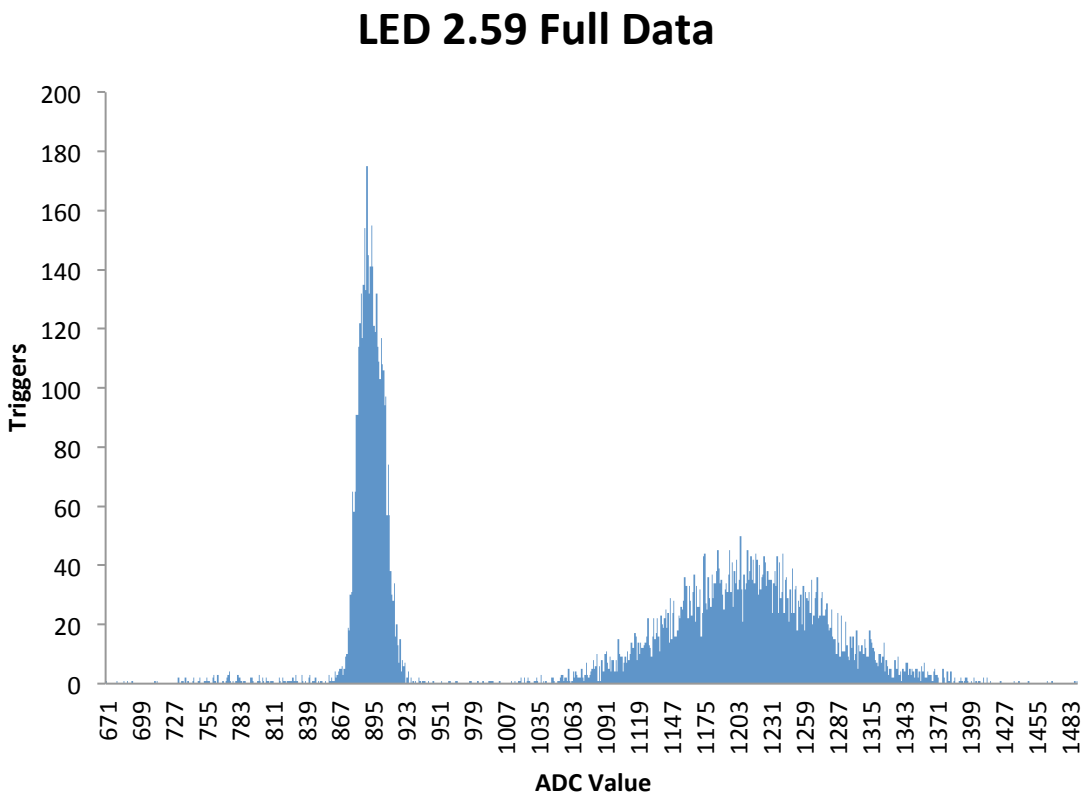
- Testing the EASIROC ASIC to see if it meets the experimental requirements of the JEM EUSO project.
- Parameters Tested
  - DAC Setting (Trigger Level)
  - Slow Shaper (reduces noise)
  - Bias Voltage Requirements
  - Gain based on voltage and temperature
  - Delay vs Gain

Lab Setup



More Lab Setup





Trial Histograms

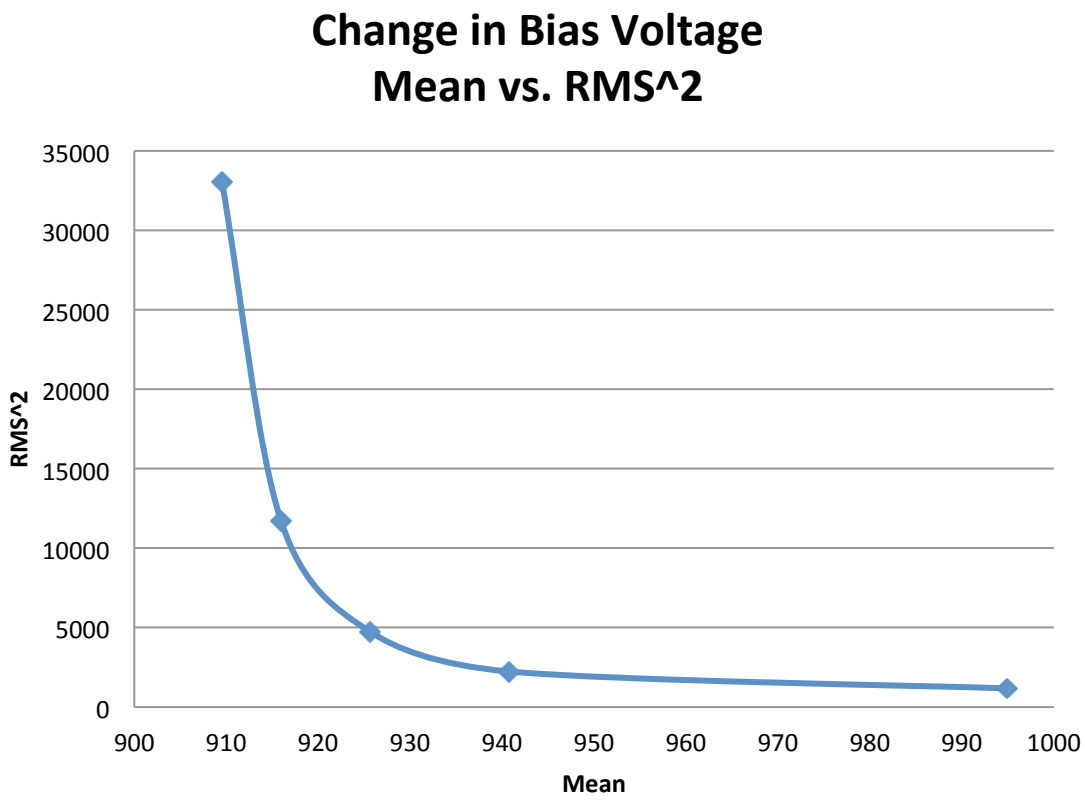
This is an example of 1 histogram that we collected from our SiPM. The EASIROC Asic records each trigger that exceeds our discriminator. The setting used for this trial had a very low discriminator to allow for all triggers.

Gain vs Voltage and Temperature

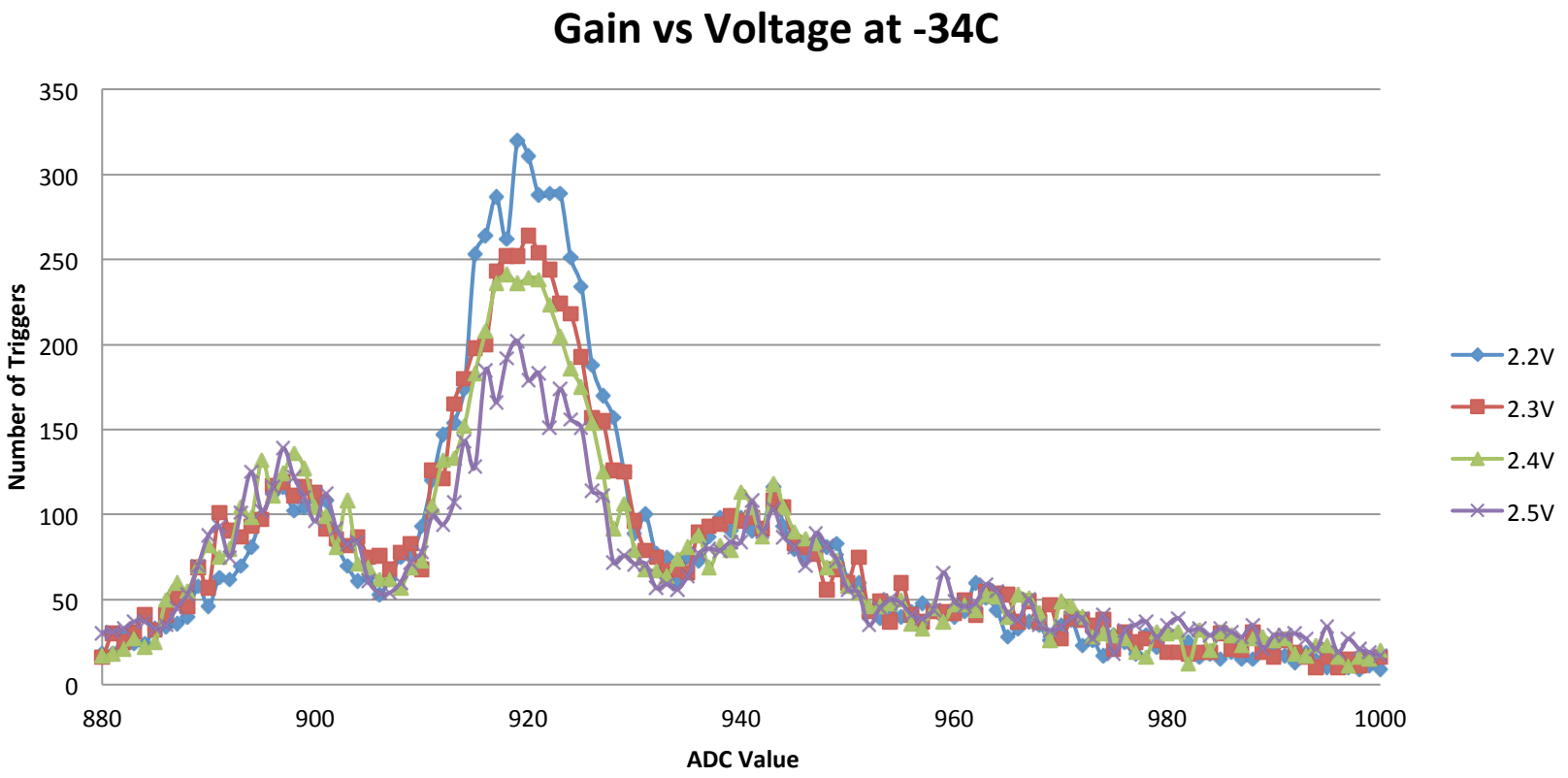
- Already know for the Hammamatsu SiPMs gain should be by the company specifications.
- Attempted to recreate the gain vs Voltage and Gain vs temperature studies.
  - This allowed us to study both the ASIC and learn more about using SiPMs

Problems

- We encountered way too much noise initially to see the photon peaks that we were expecting.
- Since we could not see the peaks for each number of photons we could not calculate the gain.
- Attempted to calculate the gain using a Poisson Distribution



This graph represents the change in mean ADC Value vs RMS^2. We were expecting to see a linear relationship between these 2 values.



Sample Data

This data shows a gain of about 20 ADC Values consistently when changing the voltage of a laser providing photons for the SiPM.

Large peak in the middle shows 1 photon hits.

As the 1 photon peak decreases we were expecting to see the 2 photon peak increase.

ASIC Comparison

	Email/Contact	Power	Discriminator	Channels	Measured Quantity	Input Configuration
Easiroc - Omega	callier@omega.in2p3.fr.	4.84mW/Channel 155mW/Chip Decrease power consumption by disabling unused features.	Individual discriminators per channel	32		
NINO - CERN	Francois.powolny@cern.ch pierre.jarron@cern.ch	240mW	Ultra-fast low power discriminator	8 or 32	Trigger, Pulse Width	Differential Input
FLC_SiPM - Orsay		Total power consumption is around 200mW with 5V supply voltage	Not mentioned	18	Pulse Charge	Current Input
MAROC - Orsay		5V supply voltage	Fast shaper and discriminator	64	Pulse Charge, Trigger	Current Input
VATA64-HDR16 IDEAS		7mW/Channel	Discriminator	64	Pulse Height, Trigger, Time	Current Input
Austriamicrosystems		7mW/channel	yes	Prototype has 3 channels but planning for more channels		
Asic designed for SUBLIMA project	ilaria.sacco@ziti.uni-heidelberg.de	8mW/Channel	Leading edge discriminator	several		
ADAS1256: 256 Channel, 16-bit charge to digital afe on flex Analog Devices		1mW/Channel to 3mW/ Channel 22us line time	Yes	256		

What am I taking away from this experience?

- Renewed interest in learning
- Greater knowledge and interest of Modern Physics
- Understanding of how my students feel with new material
- Some really great ideas for my classroom.

Applications for the Classroom

- I will be looking into the quarknet program and utilizing the cosmic ray detectors that are available.
- I will also look into using more electronics in the physics classroom. They provide a huge amount of variables for the students to understand and ultimately control in an experiment.

Side Projects

- I was able to create a cloud chamber with the help of Juan Estrada, Javier Tiffenberg, and Yash Lagisetty.
- I was also able to explore 5 different experiments using a Van de Graaf generator

Cloud Chamber